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[Review]

A historical view of the Fossil Club to the Fossil Research Society of Japan

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Abstract

After the introduction of biological techniques and methodology, paleontology revived as paleobiology, outgrowing the classical studies, which had hitherto been limited only to morphological description and classification. In Japan one outcome of the modernization in paleontology was the launch of the Fossil Club in 1959. Here were described the brief history on the foundation of the Fossil Club, the developments leading up to the Fossil Research Society of Japan, and then their contribution to paleobiology.

Key words: the Fossil Club, paleobiology, paleobiochemistry, biomineralization, SSOEL-Japan, molecular paleontology

Introduction

In 1959 when the Fossil Club was founded, I was carrying out a paleontological study on pectinid fossils as a doctoral dissertation thesis of the Tokyo University of Education. This thesis entitled "Studies on the Phylogeny of *Patinopecten* in Japan" was completed in 1961 using ordinary paleontological methods (Akiyama, 1962). During studying at the graduate school, I had been not satisfied by classical paleontology using only morphological criteria. The long-term objectives of the Fossil Club to pursue the evolution by modern biological techniques strongly appealed to me. From the beginning I participated in the Fossil Club as an active member and started on a biochemical study. The discovery of amino acids in fossils by Dr. P. H. Abelson (1954) drove me to paleobiochemistry.

In this short note I describe the foundation and development of the Fossil Club from my personal view.

Foundation and activities of the Fossil Club

The Fossil Club was founded by Dr. Shoji Ijiri and his collaborators on November, 1959. Twenty six paleontologists met together in Tokyo to study the microstructure and organic matter of fossils using the modern techniques from biological sciences, and three research groups were organized; namely the Paleoecology group (Leader: Professor M. Morishima), the Microstructure study group (Leader: Dr. T. Fujiwara) and the Evolution study group (Leader: Dr. S. Ijiri). At that time this Club had 85 members from various fields such as geology, paleontology, biology, anatomy, biochemistry and dentistry (Figs. 1 and 2).

It was really big advance when Dr. P. H. Abelson detected fossil amino acid molecules back to Devonian fossils using paper chromatography, and proposed a new field for the study of fossil molecules as "Paleobiochemistry" (Abelson, 1954).

In Japan Dr. S. Ijiri had already started a chemical study on fossils using biological techniques during World War II, but his study was unfortunately overtaken by Dr. Abelson. Dr. Ijiri with Dr. T. Fujiwara (1958) detected collagen molecules in Mammoth teeth from the Late Pleistocene, and showed that the molecules still had calcification ability *in vitro* (Ijiri

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Fig.1 After the first meeting of the Fossil Club at the Tokyo University of Education on May 6, 1960 (Photo by the late Prof. M. Morishima).
First row (from left) : Yukio Kuwano, Ken'ichi Ishii, Yukinori Fujita, unidentified, Tsutomu Fujie, Iwao Kobayashi, Junji Itoigawa, unidentified, Tadao Kamei, Daikichiro Shimizu. Second row (from left) : Masahiko Akiyama, Saburo Akagi, Setsuko Kinosaki, Takayo Fujiwara, Yoshio Kaseno, Masae Omori, Matsutaro Shibata, Masao Morishima, Atsuyuki Mizuno, Shoji Ijiri, Shigemoto Tokunaga, Tsutomu Utashiro.

Fig.2 The first field excursion of paleoecology to Aburatsubo of the Miura Peninsula, Kanagawa Prefecture on May 8, 1960 (Photo by the late Prof. M. Morishima).

and Fujiwara, 1959). Many postgraduate students including myself in Tokyo University of Education (the antecedent of the University of Tsukuba) started to study the biochemical and microstructural analysis both of various fossils and of modern hard tissues under the leadership of Prof. Masae Omori.

In those days I succeeded in detecting amino acid molecules from various molluscan fossils by paper chromatography (Akiyama, 1964). Following a suggestion from Dr. Abelson, I made contact with Prof. Marcel Florkin of University of Liege, Belgium, in whose laboratory many collaborators were conducting active studies on animal hard tissues. In 1966 Prof. Florkin published an important book titled "A Molecular Approach to Phylogeny" (Elsevier). This book was translated into Japanese by members of the Fossil Club under the supervision of Prof. Emeritus Fujio Egami of the University of Tokyo, and was published in 1969 from the Tsukiji Shokan Co., Ltd. with the permission of Prof. Florkin and Elsevier. During this translation job, Prof. Florkin came to Japan on May, 1968. At the meeting with him in Tokyo, he gave us an exciting impetus to promote our researches (Fig. 3).

In the same year I had the good opportunity to carry out geochemical work on amino acids in Cretaceous sediments (Akiyama and Johns, 1972) at Prof. William D. Johns' Lab in Washington University, St. Louis, and then biochemical work on amino acids in fossil shells of various geologic ages (Akiyama and Wyckoff, 1970 ; Akiyama *et al.*, 1971) at Prof. Ralph W. G. Wyckoff's Lab in the University of Arizona. Prof. Wyckoff was one of the distinguish leaders in the study of organic molecules from fossils (Wyckoff, 1972).

On the basis of 10 years activities in paleobiology, members of the Fossil Club published a book titled "Research Methods of Fossils (in Japanese)" from the Kyoritsu Shuppan Co. Ltd., Tokyo (Fossil Club, 1970). This book was a kind of a bible for Japanese paleontologists, which consisted of the following four chapters ; (1) classical methods for various taxa at the organ level, (2) various methods at the tissue and/or microstructure level, (3) biochemical

Fig.3 After the dinner party with Prof. M. Florkin at Tsukiji, Tokyo on May 21, 1968.
First row (from left) : F. Egami (University of Tokyo), M. Florkin (University of Liege), S. Akabori (Osaka University), M. Omori (Tokyo University of Education). Second row : S. Doi (Tsukiji Shokan, Co. Ltd.), S. Tsuru (University of Tokyo), N. Shimazono (University of Tokyo), K. Imabori (University of Tokyo). Third row : I. Kobayashi (Tokyo University of Education), S. Sasaki (Tokyo Medical and Dental University), S. Tokunaga (Geological Survey of Japan), M. Akiyama (Tokyo University of Education).

methods and structural analyses of molecules, and (4) synthesis of biominerals *in vitro* and biological experiments *in vivo*. An overall revised edition of this book titled "Research Methods of Fossils - sampling to the most up-to-date methods (in Japanese)" was published by the same publisher (Fossil Research Society of Japan, 2000).

Biomineralization study of animals and plants

At the beginning one of the big projects in the Fossil Club was to study biomineralization of hard tissues in animals and plants. In 1970 the First International Symposium on Biomineralization was held in Mainz, Germany under the organization of Prof. H. K. Erben of Bonn University (Erben, 1972). Before the symposium, an interdisciplinary symposium on the mineralization of hard tissues was held at Hakone, Kanagawa Pref., Japan in 1966, where biochemists, paleontologists and biologists met together under the leadership of Prof. Shinpei Araya and Dr. S. Ijiri (Araya *et al.*, 1969).

Prof. M. Omori of Tokyo University of Education organized the research group on "Microstructure study of fossils" supported by a research grant from the Ministry of Education, Science and Culture in Japan. This research activity was thought to be a successful basis for the symposium at Hakone. The publication of the results in 1966 was succeeded by the Fossil Club Bulletin, the official journal of the Fossil Club (the antecedent of the Fossil Research Society of Japan).

Thereafter, the International Symposium on Biomineralization has continued every three or four years until the present. It is worth writing that three symposiums were held in Japan, namely; the 3rd symposium organized by Profs. M. Omori and S. Kobayashi at Kashikojima in 1977 (Omori and Watabe, 1980) and the 6th by Profs. S. Suga and H. Nakahara at Odawara in 1990 (Suga and Nakahara, 1991), and the 8 th by Profs. I. Kobayashi, Y. Kuboki and T. Matsunaga at Kurokawa-Niigata in 2001 (Kobayashi and Ozawa, 2004). These symposiums in Japan succeeded through the participation of many members of the Fossil Research Society of Japan which was promoted by the Fossil Club in 1983.

The Society (http://www.kaseki.jp) has 202 members of anatomists, biologists, geologists and paleontologists as of May 2005. The official journal, Journal of Fossil Research (Fossil Club Bulletin) has continued up to Vol. 38 in 2005.

Contributions to the study on origins of life

In 1971 Prof. Haruhiko Noda organized a research group entitled "The study of the origin of life on the primordial earth" supported by a research grant from the Ministry of Education, Science and Culture in Japan. I joined this group at the beginning with a few paleontologists of the Fossil Club. Thereafter, the Society for the Study of the Origin and Evolution of Life JAPAN (SSOEL-Japan) was founded in 1975, and a leading part was taken by the members of the above research group. The official journal "*Viva Origino*" has continued up to Vol. 33 in 2005.

The 2nd meeting of the Society for the Study on Origin and Evolution of Life (SSOEL) and the 5th International Conference on the Origin of Life (ICOL) were held at Kyoto in 1977, supported by SSOEL-Japan. Proceedings of the meeting were edited by Noda (1978).

After the conference I was invited by Prof. Cyril Ponnamperuma of the University of Maryland to detect amino acids from Precambrian rocks. Since the end of the 1960's, many people had given up approaching the origin of life using molecular fossils, though amino acids from fossils had been detected from Precambrian sedimentary rocks in various localities of the world. This was due to the paper of Abelson and Hare (1969) where fossil amino acids in the Proterozoic Gunflint chert were proved to be all contaminants from the racemization reaction experiments. We tried to challenge the work of Abelson and Hare, and showed the possible existence of stable amino acids in the Proterozoic cherty rocks in Greenland using racemization reaction by heating experiments (Akiyama *et al.*, 1982).

Molecular paleontology

The next surprise was that fossil DNA molecules of 820 residues were detected from fossil *Magnolia* leaves of the Miocene Clarkia flora (Golenberg *et al.*, 1990). But some scientists doubted whether such unstable molecules as DNA survived for such a long period of more than 10 million years. Poinar *et al.* (1996) published in a paper that DNA molecules were never detected in fossil materials with D/L ratios

more than 0.08 in aspartic acids. It was quite improbable for DNA molecules to survive in Miocene fossils even in reduced environments. The molecules detected from the Miocene fossils must be unreliable. However, the paper is of great significance in the history of fossil DNA studies, even though not true. Then, undoubted fossil DNA fragments were detected from insect fossils preserved in Cretaceous ambers (Cano *et al.*, 1993). It should be emphasized that such kinds of paleobiochemical works are made possible by the PCR amplification method. Unfortunately, fossil DNA studies were not developed in Japan due to the poor preservation of fossil specimens in the Japanese Islands.

M. Calvin (1969) emphasized the importance of the study of hydrocarbon molecules preserved stably in ancient rocks including even the Precambrian, and proposed the field of fossil molecule studies as Molecular Paleontology. In the progress of organic geochemistry, much attention has been paid to biomarkers. Photosynthetic microbes and eukaryotes were proved in 2.7 billion years-old rocks by the presences of 2-methylhopane and C28-C30 steranes, respectively (Summons *et al.*, 1999). In Japan many young geologists and geochemists of the Japanese Association of Organic Geochemists have contributed to biomarker studies (http : //www.ogeochem.jp). This Association was established in 1972 under the leadership of Prof. Kazuo Taguchi, Tohoku University and others including myself.

Conclusive remarks

The theory of evolution was established by Charles Darwin, who published the distinguished classical book "On the Origin of Species by Means of Natural Selection" in 1859. The Japan Science Council held a lecture meeting at Ueno Park, Tokyo in 1959 to celebrate the anniversary of the theory of evolution, where many biologists and paleontologists met together to discuss the current studies of evolution at that time (Oka, 1960).

One of the leaders in the Palaeontological Society of Japan stated that paleontology could give only evidences of evolutionary results but no causes of evolution. Unfortunately, this is the limitation of classical paleontology and was also the common opinion of paleontologists in Japan. A new methodology had been sought by young paleontologists in those days. It is natural to say that the Fossil Club was born to create the modernization of paleontology (paleobiology) as a logical consequence. Young members of the Club devoted themselves entirely to introducing current biological and biochemical techniques to fossil researches. As a result they succeeded in publishing many papers on microstructure and biochemistry of various fossil specimens and the methodological book stated above.

During the modernization of paleontology by members of the Fossil Club the very important suggestion was pointed out by Dr. S. Ijiri (1988) on the fossil researches as follows "It is absolutely necessary for us to soak up information on modern biological techniques to promote the palaeontological theory of evolution. However, this is a different story from interpreting palaeontological evidences by modern biology." It is very regrettable that Dr. Ijiri passed away in December, 2000 while at the half way stage of completing his work on evolution. He was not only a leader on evolution theory (Ijiri, 1987 ; 2001) but also a pioneer of paleobiological works (Ijiri, 1939 ; Ijiri and Fujiwara, 1958 ; Ijiri, Fujiwara and Kobayashi, 1962) in Japan.

His contribution to paleobiology had already started in his distinguished work on a Miocene *Desmostylus* specimen (Kohno, 2000). He proposed the "Invagination hypothesis" which interpreted the morphogenesis of mammalian teeth from developmental mechanics of enamel organs (Ijiri, 1938). Thereafter, he pointed out that the limited geological life-range of the genus *Desmostylus* is consistent with the negative variation hypothesis deduced from variation characters in its unerupted teeth as well as third molar teeth of human beings (Ijiri, 1940).

Dr. Ijiri (2001) stated "the systems of palaeontological evolutionary theory (summaries)" in his posthumous manuscripts, which are composed of the following five chapters with an appendix of experimental paleontology ; namely, (1) species, (2) variation, (3) selection, (4) inheritance of acquired character, and (5) phylogeny.

This brief note should be completed by young paleontologists, and the paleontological theory of evolution will come into the limelight on the basis of modern paleobiological works in the near future.

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